ASAMPSA_E FIRST END-USERS WORKSHOP

Uppsala, Sweden

May 26-28, 2014

"Where must efforts be placed to establish useful guidance (or complete existing ones) for the development and use of extended PSA for NPPs?"

SUMMARY OF RECOMMENDATIONS

These recommendations reflect:

- the End-Users survey responses,
- the discussions during the workshop.

They have been reviewed by the workshop participants who have also defined a priority level based on the following scale:

- *Type A : for most important end-users needs (and for which the project should produce adequate guidance),*
- *Type B : for intermediate needs (the project will address them if possible)*
- *Type C : less important needs (not addressed by the project)*

GENERAL CONSIDERATIONS ON *EXTENDED PSA*

N°	Recommendations	WP	Type
1	ASAMPSA_E shall examine which type of cost/time analysis is acceptable to limit resources needed for external/internal hazards PSAs. Comment: the ASAMPSA_E response to this recommendation will depend on partners' experience.	30	A
2	ASAMPSA_E shall address risk monitoring and training applications of extended PSA.		C
3	ASAMPSA_E shall address PSA communication towards public.		C
4	Concerning the scope of the ASAMPSA_E project, ASAMPSA_E shall at least address the 10 more important external hazards for the End-users : - Earthquake - Flooding - Extremes air temperatures - Snow pack - Lightning - Storm (tornadoes, hurricane, …) - Biological infestation - Aircraft crash - External fire - External explosion. ASAMPSA_E shall consider also : - Internal fires, floods and explosions, - heavy load drops, high energy line break (HELB), missiles, chemical releases; - Other extreme weather conditions, - transport of dangerous substances, accidents in facilities located in the vicinity of NPP, - Releases into the waters and ground. ASAMPSA_E shall also examine the interest of integrated (all hazards and IE) or separated PSA model	21 22 30 40	A
5	Some End-Users have expressed interest on best practices to model ageing in PSA. The End-Users workshop participants have considered that it is not feasible to handle this difficult topic in the framework of ASAMPSA_E.		C
6	ASAMPSA_E shall consider a modification of the definition of extended PSA based on End-Users remarks : "An extended PSA (probabilistic safety assessment) applies to a site of one or several Nuclear Power Plant(s) (NPP(s)) and its environment. It intends to calculate the risk induced by the main sources of radioactivity (reactor core and spent fuel storages, other sources) on the site, taking into account all operating states for each main source and all possible relevant accident initiating events (both internal and external) affecting one NPP or the whole site.	50	Done

7	**ASAMPSA_E shall provide practices and methods to model the combinations/correlations/dependencies of hazards (in terms of both occurrence and impact on SSCs).**	**21 22**	**A**
8	**Concerning the combinations/correlations/dependencies of hazards, some different rules can be provided depending on the time frame (for example, addition of independent hazards may be considered for long lasting accident)**	**21 22**	**B/C**
9	**ASAMPSA_E shall address methodology for simultaneous accident progression in core and SFP.**	**22 40**	**A**
10	**ASAMPSA_E shall group the list of hazards to develop its guidance**	**50**	**A**
11	**ASAMPSA_E shall discuss the level of conservatism (same level in all PSA parts …?)**	**30**	**A**
12	**ASAMPSA_E shall provide guidance on the place of extended PSA in risk informed approach and decision-making.** **How to consider hazards if related PSA are not mature yet?**	**30**	**B**
13	**Concerning results presentation** - **Guidance on risk aggregation will be useful,** - **Results shall be understandable,** - **Risk targets are useful but not essential,** - **Treatment of uncertainties is essential (for external hazards, low probability events with high uncertainties),** - **Need for guidance for results interpretation and use.** **Introduction of uncertainties in L1 PSA may be crucial (?)**	**30**	**A**
14	**ASAMPSA_E shall address specific guidance on quality of extended PSAs.** **Associated to quality, the <u>necessity to be aware of risks</u> should be clearly emphasizes in the applications of extended PSAs: this is the main product of PSAs (extended) and must be associated to communication, training of operators, decision-making on plant safety.** **PSA "capability" concept (closely associated with PSA application) may be used instead of quality.** **(ASAMPSA_E shall examine the methodologies (to perform PSA) to be applied depending on the PSA application (see also IAEA standards, US-NRC regulatory guides))**	**30**	**B**
15	**ASAMPSA_E shall examine how to include mobile equipment in PSA.**	**22**	**A**
16	**ASAMPSA_A shall clarify the vocabulary on "mission time", "scan time". "Mission time" for NPP may be the time needed until stable state conditions are reached. "Missions times of each equipment" can be different.** **ASAMPSA_E shall examine what does it means for L1PSA, L2PSA and provide guidance to model long lasting accident.**	**22**	**A**

17	ASAMPSA_E shall develop a glossary, common for all PSAs	30 21 22 40	A
18	ASAMPSA_E shall examine how and when "seasonal PSA (winter/summer)" must be developed. An example could be useful.	22 30	A

HAZARDS SCREENING AND MODELLING

N°	Recommendations	WP	Type
19	According to the End-Users survey, existing screening guidance have to be adapted or completed for each application. ASAMPSA_E shall examine why and how to do this adaptation/complement. ASAMPSA_E shall examine how to reduce heterogeneity in quantitative screening criteria (collect and examine the screening values) ASAMPSA_E shall examine which hazards must not been screened out and why. ASAMPSA_E shall comment how far the impact of the hazards must be considered in the screening out process (in case of cliff edge effect, no screening out …?).	30	A
20	ASAMPSA_E shall examine the relevance of conditional core melt probabilities and conditional containment failure probabilities (and conditional LER probability) in the screening criteria.	30	A
21	ASAMPSA_E shall examine PSA practices for modelling induced internal floods and internal fires.	22	A
22	ASAMPSA_E shall examine SFP accident screening practices	30	A
23	ASAMPSA_E shall discuss the link between screening criteria and design basis conditions : - PSA should focus on area that are not in the design basis – example : specific combinations like hazards + induced effects) - PSA should include hazards in the design basis (useful for PSR for example)	30	A
24	ASAMPSA_E shall discuss the sum of hazards frequencies (final comparison with numerical safety target)	30	B

25	**ASAMPSA_E shall examine what to do if the sciences cannot provide information for low frequencies events or extremely high uncertainties on their amplitude.** **Examples of issues: PSA shall present uncertainties as they are? Which use of percentile value (%-ile value) is meaningful…?**	**30**	**A**
26	**Deficiencies on internal hazards modelling shall be covered in ASAMPSA_E:** **-more realistic assessment of the hazard frequency or consequences have to be developed for internal fire and flooding assessment,** **-no specific methodologies exist for internal explosion, missiles or quantification of internal hazards due to inappropriate human actions,** **-the methods for hazard curves and fragility curve constructions are not described.**	**21** **22**	**A**
27	**In ASAMPSA_E project, uncertainties assessment methodology for internal hazards shall be compared and good practices identified.** **Is the fragility curves approach always relevant (example: spurious signal in case of fire) ?**	**22**	**A**
28	**In ASAMPSA_E, existing methods for external hazards modelling shall be presented and compared including uncertainties**	**21**	**A**
29	**ASAMPSA_E shall examine how experts judgement shall be used for external hazards characterisation and how uncertainties can be considered**	**21**	**B**
30	**ASAMPSA_E shall introduce the effects of climate changes and present available methodologies. Need for updating PSA.**	**21**	**A**
31	**ASAMPSA_E shall examine the role of statistical analysis method (e.g. EVT) based on observation in comparison with approaches trying to identify which combination of factors can lead to the worst meteorological events (not observed).**	**21**	**A**
32	**ASAMPSA_E shall examine how PSAs can introduce information coming from meteorological modelling.** **Example: variations from past worst cases?**	**21**	**A**
33	**A fact: clear underestimation by the 1999 earthquakes map when compared to recent earthquakes. One reason is that PSHA interprets historical data (based only on 100 years of records). It is need today to introduce faults sources.** **ASAMPSA_E shall provide information on activities performed to assess catalogue completeness and reliability, on how to assess the max. possible earthquake (Mmax), identify, analyse and assess (potentially) active faults relevant to the safety of the site …**	**21**	**A**

34	A fact: in a region with low seismicity like Sweden, an earthquake M 8 is "possible" (and observed in paleo history) with a return period 1 million years … ASAMPSA_E shall examine how can such information be presented in a PSA	21	A
35	ASAMPSA_E shall insist on the need to update periodically the design-basis hazards curve	21	A

INTRODUCTION OF HAZARDS IN L1 PSAs

N°	Recommendations	WP	Type
36	ASAMPSA_E shall identify some best practices for external hazards SCC fragility analysis, e.g.: - at which temperature an electronic device fails, - shaking tables for active equipment …, - fragility curves database. ASAMPSA_E shall share opinion on available information related to fragility of equipment (database ….). Emergency diesels are so important that related methodologies / data should be specifically analysed in ASAMPSA_E	22	A
37	ASAMPSA_E shall examine (on examples) the importance of non-safety systems robustness/behaviour/positive vs negative impact in case of external hazards on final CDF/RF (example, in extreme cold temperature conditions, ventilation can accelerate pipe freezing if not stopped).	22	A
38	For seismic PSA, ASAMPSA_E shall examine the interest of advanced PSA methodologies using "earthquake signal (temporal ground motion parameters) impacts on SSCs and interest in comparison with "classical" methodologies (PGA …).	22	A
39	Seismic PSA may be based on the use of generic fragility curves for components … How can the PSA End-Users justify their use? ASAMPSA_E guidance shall comment this issue from partner experience.	22	A
40	SFP specific issues for earthquake (to be considered in ASAMPSA_E): • fragilities of the pools, racks. • sloshing of the pool water (one combination of hazards, what are the consequences for accident progression? See TEPCO presentation during End-Users workshop in Uppsala), • loss of cooling.	22	A
41	The following topic shall be discussed in ASAMPSA_E (guidance needed): induced internal hazards are potential source of conservatism (if included), of non-conservatism (if not included).	30	A

42	For flooding : • ASAMPSA_E shall compare some applications for flooding assessment in EU stress-tests before developing guidance, • fragility of equipment may be easily presented (failure in case of room flooding) (according to some experts in the Uppsala workshop), • ASAMPSA_E shall present methodology to address long term flood • the uncertainties may be higher for natural than for man-made hazards (according to some experts in Uppsala workshop)	21	A
43	ASAMPSA_E shall develop guidance to assess frequencies of LHS events (how to arrive from an external hazard to an IE?)	21 22	B
44	ASAMPSA_E shall develop guidance to calculate frequencies of LOOP and recovery time (these frequencies shall be updated with grid modernization). How to consider the recovery time of grid?	21 22	B

INTRODUCTION OF HAZARDS IN L2 PSAs

N°	Recommendations	WP	Type
45	ASAMPSA_E shall identify issues associated to external hazards that may need significantly different treatment in comparison with L2PSA methodologies for internal IE, e.g: - Induced effects (internal hazards) by external hazards, - Earthquake aftershocks, - External hazards impact on containment function …	40	A
46	For ASAMPSA_E guidance on L2 PSA : - Extended L2PSA shall include long term management of radioactivity in the containment and release in environment. - ASAMPSA_E shall consider in long term strategies both in-vessel retention and ex-vessel retention	40	A
47	ASAMPSA_E shall examine existing containment venting strategies optimization versus L2PSA results (status today: different strategies, depending on NPPs – is it consistent with L2PSA results?)	40	A
48	ASAMPSA_E shall examine SAMG sufficiency, especially for shutdown state (SAMG needed to develop event trees …)	40	B
49	For shutdown states of reactor, ASAMPSA_E shall propose guidance for : - Open RCV or RCS situations : FP release (effect of air ingress), thermal radiation effect on the containment integrity (open RCV case, heat load),	40	A
50	ASAMPSA_E shall examine how can be calculated the conditional probability of SFP fuel degradation after core melt (depending on common system core/SFP, on location of SFP –	40	A

	inside vs outside containment) **ASAMPSA_E shall examine how far, in case of SFP fuel degradation (inside a containment), the containment function can survive (depending on pressurisation, hydrogen production, thermal radiation load …)** **ASAMPSA_E will need to map the NPP configurations of reactor core versus SFP (independence).**		

COMMON ISSUES FOR MULTI-UNITS PSA (FOR ALL EXTERNAL HAZARDS)

N°	Recommendations	WP	Type
51	ASAMPSA_E shall clearly identify deficiencies of single units PSA and promote development of multi units PSA.	22 40	A
52	ASAMPSA_E shall examine if a new set of risk metrics for multi-units is necessary	30	B
53	ASAMPSA_E shall consider experience of countries like Canada having already developed multi-units PSA.	22 40	B
54	ASAMPSA_E shall in particular examine HRA modelling demand for multi-unit PSA (e.g. team sufficiency if shared between units, site management complexity, equipment restoration possibilities, inter-reactor positive or negative effects …)	22 40	A
55	For comments in ASAMPSA_E guidance : Earthquake can affect multi-units. The ground motion is correlated but can be different for each reactor (this is an issue examined in Japan). True for other external hazards.	22	C

COMMON ISSUES FOR HRA MODELLING (FOR ALL EXTERNAL HAZARDS)

N°	Recommendations	WP	Type
56	ASAMPSA_E shall examine how to improve HRA modelling for external hazards conditions to tackle the following issues : - the high stress of NPP staffs, - the number of tasks to be done by the NPP staffs, - the impossibility, for rare events, to generate experience or training for operators actions (no observation of success/failure probability (e.g. simulator), - the possible lack of written operating procedures (or approximate procedures), - the possible wrong information in the MCR or maybe the destruction of the MCR, - the methodologies applicable to model mobile barrier installation (for slow developing event), - the methodologies available to model use of mobile equipment (pumps, DGs) and conditional failure	22 and 40 (TBD)	A

	probability (human and equipment), - the methodologies applicable to model equipment restoration (long term accident sequences, specific case of multi-units accidents, …).		
57	ASAMPSA shall examine methodologies to develop modelling of "warning" for slowly developing external events	22	A
58	ASAMPSA_E may organize a workshop with HRA specialists	50	C
59	ASAMPSA_E shall develop guidance on error of commission	22	B/C

SPECIFIC ISSUES OF INTEREST FROM EXPERIENCE OF PAST REAL EVENTS

N°	Recommendations	WP	Type
60	ASAMPSA_E guidance shall explain how to introduce in L1-L2PSA a more diverse modelling of internal and external electrical disturbances. The Forsmark NPP experience presented during the ASAMPSA_E End-Users workshop in Uppsala shall be considered as a starting point (include in PSA voltage surge on plant grid (e.g. lightning)) Comment : providing examples of assessment may be useful if feasible in the framework of ASAMPSA_E.	22	A
61	ASAMPSA_E guidance shall identify methodologies available to quantify the frequency of loss of heat sink due to natural hazards (e.g. clogging effect). An additional question that can be addressed is criteria (from PSA perspective) from which a design change can be needed? The Cruas NPP example provided by EDF (loss of heat sink) during the ASAMPSA_E End-Users workshop in Uppsala can be considered as a starting point. Comment : providing examples of assessment may be useful if feasible in the framework of ASAMPSA_E	22	A
62	From Le Blayais NPP example, ASAMPSA_E shall explain for external flooding PSA that : • Conditional CDF can be calculated depending on event flooding amplitude, • Initiating flooding events (amplitude, frequency) can be modelled separately from PSA This can be a starting point for some ASAMPSA_E guidance on external flooding.	21 22	A
63	ASAMPSA_E may ask meteorological institutes information on climatic events to complete D10.3	10	B
64	Past earthquakes in Romania (it affected a Bulgaria NPP) and Armenia could complete D10.3	10	A
65	ASAMPSA_E may propose a format for a database to get information on past events.	10	B